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CARRIER BASED AIR LOGISTICS STUDY--DATA SOURCES AND ISSUES.(U)

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A RAND NOTE

**CARRIER BASED AIR LOGISTICS
STUDY--DATA SOURCES AND ISSUES**

L. Embry, P. K. Dey

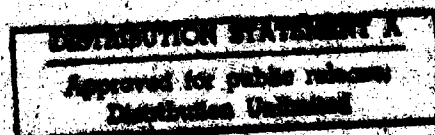
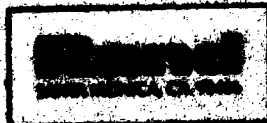
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The primary objective of the Carrier Based Air Logistics (CABAL) study was to identify and evaluate alternative logistics support policies which could improve wartime aircraft availability and operational performance. This Note describes the data base developed to support the CABAL analysis. An essential first step in the analysis was the development of a data base describing the configuration of avionics suites, and the characteristics of components that make up the suite for the six aircraft. The Note describes the data elements in the data base, identifies their sources, and discusses the data problems encountered in the study. Also described generally are the uses of the data. The Note concludes with a discussion of data quality problems which surfaced during the analysis. 31 pp. Ref. (Author)

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A RAND NOTE

CARRIER BASED AIR LOGISTICS STUDY--DATA SOURCES AND ISSUES

L. Embry, P. K. Dey

January 1982

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PREFACE

The Carrier Based Air Logistics (CABAL) study has two primary purposes: (1) to evaluate a specific alternative to the current logistics support structure suggested for further analysis in the Defense Resource Management Study (DRMS) report to the Secretary of Defense (February 1979) and (2) to identify and evaluate potential improvements in the current logistics support structure that could enhance aircraft availability during wartime without the complete structural change required by the DRMS alternative.

The study focuses on key logistics elements that support carrier aircraft, including the supply system, shipboard component repair facilities (including test equipment), maintenance manpower for those facilities, and transportation for the resupply of components not reparable aboard ship and the return of components to be repaired at depot facilities. Changes suggested in this study are directed toward improving the readiness and availability of carrier based aircraft rather than toward reducing cost. Most recommendations suggest implementation rather than further study. In those cases that warrant further study, the Navy either is already performing such analysis or has an in-house capability for doing so.

This Note describes the data base developed to support the CABAL analysis. It is intended primarily for those concerned with data sources or with maintaining the data systems from which the CABAL data were extracted. A companion report, R-2853-NAVY, Carrier Based Air Logistics Study, Integrated Summary [Ref. 3], provides an overview of

the entire CABAL analysis. Companion documents describing further uses of the data are:

N-1758-NAVY, Carrier Based Air Logistics Study--Supply and Transportation Analysis, Ref. 2.

N-1784-NAVY, Carrier Based Air Logistics Study--Maintenance Analysis, Ref. 4.

This work was sponsored by the Office of the Chief of Naval Operations (OP-51).

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SUMMARY

The primary objective of the Carrier Based Air Logistics (CABAL) study was to identify and evaluate alternative logistics support policies which could improve wartime aircraft availability and operational performance. A key study task was to examine in further detail a specific alternative to the current logistics support structure outlined in the Defense Resource Management Study (DRMS) [Ref. 6]. In addition to addressing the DRMS structural alternative, the CABAL study was to search out options for improving support policies within the current logistics structure. The results of this review are reported in the CABAL Integrated Summary [Ref. 3].

Development of a data base describing the configuration of avionics suites, and the characteristics of components that make up the suites, for the six aircraft* to be considered was an essential first step in the analysis. Since the data needed for the CABAL study are essentially those required for level of repair (LOR) and logistics system performance evaluations, the study began with the premise that a central file containing most needed data elements was available. When this proved not to be true, efforts were shifted from trying to find a single source for the data to identifying sources for the individual data elements. This ultimately entailed considerable manual effort to create cross references between components and test stands, maintenance and supply data systems, and so forth.

* The aircraft considered were the A-6E, EA-6B, KA-6D, E-2C, F-14A, and S-3A.

Development of this data base consumed more time than had been contemplated at the outset of the study. Numerous problems were encountered in attempts to validate data across sources and to provide a complete avionics suite description. Although some questions regarding data quality remain, the data base development did produce the product needed to support the analysis. In the process, it identified a variety of deficiencies in existing Navy data systems. Most of these problems are now being corrected by the Navy.

ACKNOWLEDGMENTS

The CABAL study could not have been performed without excellent cooperation from the U.S. Navy. Admiral P. H. Speer (OP05B) and the entire Navy Advisory Board provided useful advice and criticism which contributed to the balance and credibility of the analysis. The study benefited immensely from the many helpful comments and criticisms of Admiral R. W. Carius (OP51) and his staff. Captain Charles Bolinger and his assistant, Lt. Commander Stanley Hunter, were instrumental in steering us to the right agencies and persons for data acquisition, orientation, and expert opinion. Without exception, Navy personnel at all levels were frank, open, and cooperative in their interactions with the CABAL study group. Manny Pierucci and Jim Kapp of the Navy Maintenance Support Office and Burke Kenny of the Aviation Supply Office were particularly helpful.

We wish to thank Frank Swofford of the Navy Secretariat for his encouragement and support throughout the study. Thanks also to Earl Gardner, who provided valuable programming assistance when it was needed.

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GLOSSARY

3M	Maintenance, Manpower, and Material Data System
AECL	Avionics Equipment Configuration List
AIMD	Aviation Intermediate Maintenance Department
ASO	Aviation Supply Office
ATC	Action Taken Code
AVCAL	Aviation Consolidated Allowance List
AWP	Awaiting Parts
B&P	Bit and Piece
BCM	Beyond the Capability of Maintenance
CABAL	Carrier Based Air Logistics Study
CLAMP	Closed-Loop Aeronautical Maintenance Program
CNA	Center for Naval Analyses
DMMH	Direct Maintenance Manhours
DODMDS	DoD Material Distribution Study
DRMS	Defense Resource Management Study
Dyna-METRIC	Dynamic Multi-Echelon Technique for Reparable Item Control
I-Level	Intermediate Level
IOL	Initial Outfitting List
JCN	Job Control Number
LOR	Level of Repair
MCRL	Master Cross Reference Listing
MDF	Master Data File
NALC	Naval Aviation Logistics Center

NAMSO	Navy Maintenance Support Office
NAVMMACLANT	Naval Manpower and Material Analysis Center, Atlantic
NEC	Naval Enlisted Classification
NIIN	National Item Identification Number
NMDL	Navy Management Data List
O-Level	Organizational Level
PIMA	Prime Intermediate Maintenance Activity
SCIR	Subsystem Capability Impact Report
SM&R	Support, Maintenance, and Recoverability
SRA	Shop Replaceable Assembly
TAT	Turnaround Time
TDBD	Top Down Breakdown
TMS	Type/Model/Series
VIDS/MAF	Visual Information Display System/Maintenance Action Form
WRA	Weapon Replaceable Assembly
WSF	Weapon Systems File
WUC	Work Unit Code

I. INTRODUCTION

The Defense Resource Management Study (DRMS) included a preliminary analysis of carrier based air avionics logistics support as part of its investigation of logistics support alternatives for a variety of combat weapon systems. The study suggested that low peacetime aircraft availability was a major problem and identified alternative policies which might improve both peacetime readiness and wartime aircraft availability.

One of the primary objectives of the Carrier Based Air Logistics (CABAL) study was to evaluate in further detail the alternative proposal in the Defense Resource Management Study. In addition, it was to identify and evaluate potential improvements in the current logistics support structure that could enhance wartime aircraft availability without the complete structural change implied by the DRMS alternative. The study was to consider the entire logistics support system and the interaction of its various functions and resources, through a detailed examination of expected wartime aircraft availability under alternative logistics structures and policies. It dealt with avionics equipment installed in six aircraft types included in most carrier deckloads--the F-14A, S-3A, E-2C, and three A-6 variants (A-6E, EA-6B, and KA-6D).

Because most of the data needed for the study are also needed to support Level of Repair (LOR) analysis and/or the development of supply requirements, the study began with the assumption that these data were centrally maintained. In fact, there is no single data base containing all (or even most) of the data needed for the CABAL study. Hence a

considerable amount of the CABAL study effort was devoted to identifying sources for and developing the data base needed to support this analysis. At least one source for nearly all the necessary data elements was identified, but creation of the CABAL data base required integration of data drawn from a variety of Navy sources.

The data covered the period July 1978 through June 1979, which preceded implementation of the Navy's Subsystem Capability Impact Reporting System (SCIR). More recent data were available, but their quality was dubious because of problems in SCIR implementation. Use of the 1978-1979 data was based on the recommendations of Navy Maintenance Support Office (NAMSOC) representatives who are custodians of the data.

This Note describes the data elements contained in the data base, identifies their sources, and discusses the data problems encountered in the study--some of which remain. The Note also describes generally the uses of the data but does not discuss the models employed during the study or the analysis results. The latter subjects are treated in Refs. 1 through 4.

Section II provides an overview of the CABAL data base; a more detailed description of data sources and individual data elements is provided in Appendix B. Section III concludes the Note with a discussion of data quality problems which surfaced during the analysis.

II. THE CABAL DATA BASE

The deckload of aircraft considered in the CABAL study was nominally that on the USS CONSTELLATION during her 1979 Western Pacific deployment. The baseline avionics configuration of the aircraft in this deckload was developed initially from the Avionics Equipment Configuration List (AECL) for the 1979 CONSTELLATION cruise. When it became apparent that much of the workload generated for avionics work centers was for components not in the AECL, the component set was expanded to include all components that had more than one intermediate level maintenance action in an avionics work center during the period July 1979 to June 1980. These components were identified using a Maintenance, Manpower, and Material Data System (3M) report generated by NAMS0. Component data were accumulated for all six aircraft type/model/series (TMS)* considered in this study.

The data base contains 13607 records, with 721 characters per National Item Identification Number (NIIN). The number of unique components by this TMS and level of indenture are shown in Table II-1. Indenture relationships** were developed through use of a Top Down Breakdown (TDBD) extract from the Navy Aviation Supply Office (ASO) Weapon Systems File (WSF).

The full set of components that might be needed to repair avionics equipment is considerably larger than that shown in Table II-1. The

* Aircraft considered were the A-6E, EA-6B, KA-6D, E-2C, F-14A, and S-3A.

** Indenture relationships define the set of subcomponents associated with a particular component.

Table II-1

UNIQUE COMPONENTS IN CABAL DATA BASE BY LEVEL

Level	Type/Model/Series					
	A-6E	EA-6B	KA-6D	E-2C	F-14A	A-3A
WRA (a)	233	172	113	173	235	182
SRA (b)	1612	1061	434	1083	2184	1709
SRA Parts	1008	536	202	326	1270	1074

(a) WRA = Weapon Replaceable Assembly.

(b) SRA = Shop Replaceable Assembly.

universe of components identified from the TDBD--about 65100 NIINs--was reduced to 50758 of interest by excluding all which had less than one 3M-recorded demand during the period July 1978 through June 1979. In addition, the five levels of indenture provided in the TDBD were collapsed to three to reduce computer processing time; this action affected less than five percent of the components. Its effect, if any, was to overstate expected performance degradation in the model runs since the effects of maintenance delays while awaiting parts (AWP) were assumed to occur at a higher level of indenture than would actually be the case.

The contents of the records developed for each NIIN are cross-referenced to the source of data in Tables II-2 and II-3. Table II-2 describes the data elements collected for reparable items. Records for items that are not repaired at the Aviation Intermediate Maintenance Department (AIMD) are described in Table II-3. These records were considerably shorter than those for reparable items because repair data were not needed. A more detailed discussion of these data elements, including their sources and uses, is provided in Appendix A. Data sources are described in Appendix B.

Table II-2

MASTER AVIONICS COMPONENT LIST FOR REPARABLE ITEMS

SOURCES

ELEMENTS	A E C L	N I L N	T o p D o w n	B r k d o w n	M C R L	N A M S O	A S O	N A M S O	N A M S O	N A V M H A C L A N T	S p e c. R u n s	M D F E x t r a c t	A S O r p t.	M K O O 0 2 b	S p e c. D a t a C o l l e c t i o n	D O D M D S
1. Type/Model/Serial	P															
2. Work Unit Code						A	A	P								
3. National Stock Number	P*	P*														
4. Family/Group Code	P															
5. Aircraft Subsystem Code	P															
6. IOL Code	P															
7. Component Code	P															
8. Sequence Code			P													
9. Material Control Code				P	A			A								
10. Common Item Code											P					
11. Quantity Per Application (QPA)	P*	P*														
12. NIIN Nomenclature				P	A											
13. SM&R Code				P	A											
14. Unit Price								P								
15. Work Center Code						P					A					
16. Total Removals							P									
17. % I-Level Repair							P									
18. Average Turnaround Time							P							P		
19. Average In-Process Days							P							P		
20. Average Awaiting Parts Days							P							P		
21. Average Scheduling Days							P							P		
22. Average Repair Days							P							P		
23. % BCM (Total)							P									
24. % BCM (Depot Only)							P									
25. % BCM (Parts)							P									
26. % BCM (Condemn)							P									
27. % No Defect							P									
28. Removals/Flying Hour							C		C							
29. Removals/Sortie							C		C							
30. % Repairs With AWP Time							P									
31. Average Days AWP for (30)							P									
32. Average TAT for No Defect (27)							P									
33. Average TAT for Parts (25)							P									
34. Average Days AWP for (25)							P									
35. Average Days TAT for ATC 2,3,5-9							P									
36. Average I-Level DMMH-ATC A							P									
37. Average I-Level DMMH Repair-ATC B,C,K,Z							P									
38. Average I-Level Elapsed Maint. Time (37)							P									
39. Gross Weight																
40. Gross Cube																
41. NEC										P						
42. Test Equip Code																
43. Average Depot Repair Cycle Time																
44. Level Indicator (WRA or SRA)											P					

a = ASO data
b = 3M data
P = Primary
A = Alternate
C = Computation element
* AECL for WRAs; Top-down for indentured components.

Table II-3

BIT AND PIECE (B&P) COMPONENT LIST

SOURCES														
ELEMENTS														
1. Type/Model/Series	P													
2. Work Unit Code			A	A	P									
3. National Stock Number		P												
4. SM&R Code			P	A		A								
5. Unit Price						P								
6. Total Removals					P									
7. Removals/Flying Hours					C		C							
8. Removals/Sortie					C		C							
9. Weight													P	
10. Cube													P	
11. Average Depot Repair Cycle Time										P				

a = ASO data
 b = 3M data
 P = Primary
 A = Alternate
 C = Computation element

USES OF DATA

Data needs were determined by input requirements for the Dyna-METRIC model, the primary analytic tool used in the analysis. These data requirements can be divided into four major groups:

- o Scenario description
- o Component maintenance parameters
- o Indentured relationships
- o Resources available to the system, including stock, manpower, and test equipment

The scenarios used in the analysis were developed from data provided by the Navy. Stockage requirements were developed from data base parameters using a model that emulated the ASO Aviation Consolidated Allowance List (AVCAL) production process [Ref. 2]. Requirements for manpower and test equipment were developed using the applicable Navy methodologies. The remaining Dyna-METRIC data requirements included component-specific maintenance parameters and a "map" relating subcomponents to the parent components in which they are installed. Dyna-METRIC maintenance data requirements are related to their sources in Table II-4.

The data were also used in a variety of statistical analyses performed to describe the maintenance process, the effects of transportation pipelines on logistics system cost, and the volume of material movement required by the current and by an alternative

Table II-4

DYNA-METRIC DATA REQUIREMENTS AND THEIR SOURCES

Dyna-METRIC Maintenance Data Requirement	Source
Name of part	AECL
Demands per flying hour	ASO Report MK0001 and NAMS0 Report 2968
Fraction BCM (a)	ASO Report MK0001
Total test time or repair time (days)	NAMS0 Report 7961
Cost of item	Navy Master Data List
Quantity per aircraft	AECL for WRAs and ASO Top Down Breakdown
Order and ship retrograde times	CNA (b)

(a) BCM = Beyond Capability of Maintenance (shipped to depot for repair).

(b) CNA (Center for Naval Analyses) was responsible for developing estimates of transportation time.

maintenance structure. The results of some of these analyses are described in companion volumes to this report [Refs. 2-4].

DATA SOURCES

The primary sources of data used to create the CABAL data base were:

- o 3M reports
- o The ASO Top Down Breakdown (TDBD)
- o The ACM-02 Manpower Standard [Ref. 5]
- o Test equipment data maintained by the Naval Aviation Logistics Center (NALC)
- o Special manual data collection efforts

The ASO TDBD was used to identify the indentured components tied to WRAs in the expanded AECL. There were five levels of indenture in the source data (WRA, SRA, B&P-1, B&P-2, B&P-3); to reduce computer processing time, the levels were collapsed to three (WRA, SRA, and B&P). Level four and five components then became level three. The effect was minimal since less than five percent of the components were affected by this reduction in the number of levels of indenture.

After the ASO TDBD, the Navy's 3M system was the most important source of data. The Navy Maintenance Support Office (NAMSO) is the central data bank for aviation 3M data. NAMSO uses the accumulated 3M data base to produce routine management information and special reports. These reports were used to establish the key maintenance parameters needed for the analysis.

The primary 3M products employed were the MK0001 and MK0002, which are generated by NAMSO for ASO use, special NAMSO reports (reports 2961, 7961, and others) that accumulate manhour expenditure and maintenance time estimates, and NAMSO report 2958, which contains historical operational data (flying hours and sorties). The MK0001 and MK0002 reports contained both component demand and repair times (constrained and unconstrained).* The special reports were used to develop maintenance manhour and elapsed maintenance time estimates for repair

* NAMSO applies constraints to individual elements of repair turnaround time for ASO's use in computing stockage requirements. The parameters are constrained to prevent statistical anomalies from generating excessive investment requirements. These elements are constrained for each observation as follows: processing time ≤ 3 , scheduling ≤ 1 , repair ≤ 8 , and AWP ≤ 20 days. The sum of these elements is turnaround time, which is itself constrained to no more than 20 days. Constrained turnaround time is the average of the constrained observations.

actions. Problems with the data contained in these reports are discussed with related data quality issues in Section III.

Unfortunately no standard data sources were available to relate components to repair resource requirements or to establish the mission essentiality of different items. The fact that the supply and maintenance communities use different codes to identify the same item* was only the beginning of the problem. Although the NALC does maintain data on the applicability of test equipments to different avionics subsystem codes, this cross reference is not available at either the Work Unit Code (WUC) or the NIIN level. Three NALC files had to be accessed to obtain a component-to-test-equipment map:

- o The Index Master File was matched to the CABAL data base, which identified the system codes and part number/NIINs of interest.
- o Nomenclature records added the test equipment description.
- o The Test Equipment File gave more information, including weight, cube, SM&R (Support, Maintenance, and Recoverability), and test equipment value.

This component-to-test-equipment map was completed through manual data collection. Maintenance skills were associated with components through use of relationships developed by the Navy Manpower and Material Analysis Center, Atlantic (NAVMMACLANT) in deriving the manpower methodology found in the ACM-02.

* The supply system identifies a component by its NIIN. The maintenance community uses Work Unit Codes (WUC), which may encompass several NIINs. Conversely, a single NIIN may have multiple WUC applications.

The specific 3M and other reports used as data sources are described further in Appendix B.

III. DEFICIENCIES IN THE DATA AND IN DATA QUALITY

Two types of data deficiencies constrained the analysis:

- o Non-availability of one needed data element
- o Quality of some of the available data

At least one source for nearly all needed data was identified during the CABAL study. The one notable exception was data concerning test equipment availability. Because of the low utilization of most test equipments installed aboard carriers, the lack of data did not severely limit the analysis [Refs. 3, 4]. Although the analytic results could have been improved by modeling the test equipment failure and repair processes, low projected equipment utilization, even for wartime flying programs, made it possible to work around this data deficiency.

Questions regarding data quality were not so easily addressed. The study identified several potentially serious limitations in the data, most of which were dealt with by processing additional reports generated by the Navy. When these problems identified possible data system deficiencies, appropriate Navy activities initiated corrective action. In addition, ASO has initiated a massive file improvement effort that will address a broad range of data problems.

Not all of these problems, however, can be corrected by audit and review action; hence the nature and likely causes of data quality problems are summarized below.

Data quality problems identified during the study included:

- o Incomplete avionics configuration data recorded in the Avionics Equipment Configuration List
- o Alternate Stock Number problems
- o Incomplete demand history records
- o Deficiencies in indentured relationship data recorded in the ASO Weapon System File
- o Master Cross Reference Listing (MCRL) limitations
- o Incomplete manhour expenditure data recorded in NAMS files, due primarily to the procedures used to perform Job Control Number (JCN) accumulations of the 3M data
- o Potential underreporting of demand

INCOMPLETE AECL

Much effort was devoted to development of a data base describing characteristics of the components to be considered in the analysis. Since the study was to include only avionics equipments, the set of components to be considered was initially based on the Avionics Equipment Configuration List (AECL) [Ref. 1] for the deckload carried by the USS CONSTELLATION on her 1979 WESTPAC deployment.

When it became apparent that a component list based on the AECL did not include many of the components that generate workload in avionics work centers,* the data base was expanded to include these other items. Items were included if they had one or more intermediate level maintenance action in any avionics work center during the period July

* That is, work load reported through the 3M system showed other components being repaired in the avionics center.

1979 to June 1980. This increased the number of item applications in the data base by about 27 percent.

ALTERNATE STOCK NUMBER PROBLEM

Head of family stock numbers* were used in the data base; ASO provided an alternate stock number data tape to update data recorded against alternates to the appropriate head of family stock number. This important step was taken to ensure that failures and repair data recorded against alternate numbers representing essentially the same component would be credited to the stock numbers in the study. After attempting to integrate five of the data sources it was found that the alternate data were in error--some of the data updated stock numbers in both directions. Programs to correct the alternate stock number data were developed and each of the five data sources had to be updated to head of family again and re-integrated into the data base.

INCOMPLETE DEMAND HISTORY RECORD

When the MK0001, the source of demand data, was run against the component list, about 15 percent of the primary components (WRAs) showed no demand worldwide for the one-year period covered by the MK0001. About 10 percent of these showed no activity in the MK0001, MCRL, or 2961--which covered a period of 1-1/2 years. The remaining five percent showed some activity in either the MCRL or the 2961, indicating problems with the MK0001. (Each of these was generated from the same 3M data source.)

* ASO groups some like components into "families" with comparable form, fit, and function. One of the NIINs is designated the "head of family."

ASO checked their own MK0001 and MK0002 files for the components for which the tapes provided to Rand showed no demand. Some system-wide demands (generally small) for many of the components were found, but ASO could not attribute them to a specific aircraft type. Nevertheless, new MK0001 and MK0002 reports were produced to ensure that the CABAL files included all relevant demand data. Processing the new tape reduced from 15 to 6 the percent of WRAs which showed no demand worldwide for one year in the MK0001.

DEFICIENCIES IN INDENTURED RELATIONSHIPS

Indentured component relationships were based on the Top Down Breakdown (TDBD) file extracted from the ASO Weapon System File. The list of WRAs from the edited AECL was run against the TDBD list to obtain all the indentured components (subcomponents (SRAs) and bits and pieces) for these WRAs. At this point it was found that about five percent of the AECL WRAs were coded as SRAs in the Top Down list, which raised questions about the validity of the configuration data.

These apparent errors in configuration were of particular concern because they can compound effects when the supply, test equipment, manpower, and transportation requirements associated with components are considered. Discussions with the Navy indicated that such errors do happen and that these SRAs should be excluded from the WRA list.

Twenty-two percent of the WRAs in the AECL list could either not be found or showed no indentured components in the Top Down list for their associated aircraft type. These WRAs were checked against the breakdown

of other aircraft since some of them belonged to systems that were common to more than one aircraft type. Although some were found, 17 percent of the WRAs still showed no breakdown into subcomponents. These were checked against the demand data and about half showed intermediate level repair activity, indicating that there should be a breakdown of repair parts for them. A list of these components was sent to ASO for further checking.

ASO found breakdowns for some of the items and these were integrated into the data base. Some WRAs should not have had a breakdown and were not in error, but the remainder represent errors in the ASO weapons system file. The number of errors (17) was small enough, however, that their effect on the study was judged to be minimal.

MASTER CROSS REFERENCE LISTING (MCRL)

The MCRL was identified as the primary source for the Work Unit Code (WUC) needed to relate components to test equipment and to provide component price data. The data, however, contained multiple WUCs for a given stock number and a special program had to be developed to select the correct one. During the integration of these data with the other sources it was found that the MCRL contained data for only some of the components. It was then necessary to identify additional sources. This problem ultimately required reprocessing the MK0001 tape to obtain WUCs and the Navy Management Data List (NMDL) for the price data.

INCOMPLETE MANHOURLY DATA

Using the original set of components from the AECL, average intermediate level maintenance manhours for repair were extracted from the NAMS Report 2961 for the period July 78 through June 79. By comparing these manhours to the ACM-02 [Ref. 5] standards, it was found that the 2961 report did not include Beyond the Capability of Maintenance (BCM) and assisting work center manhours.

NAMS provided a new Report 7961* for the period July 79 to June 80 to resolve the problem. However, when compared with ACM-02 data, this tape also appeared to have incomplete manhour expenditures. Discussion with NAMS suggested that the problem resulted from the procedures used to perform Job Control Number (JCN) accumulations of manhours for each component in the 3M data.

To overcome this problem NAMS generated a special extract of the raw 3M data which was used to update the CABAL data base. Table III-1 compares, by aircraft, the average weekly maintenance manhours found in the CABAL data base (after each manhour update) with the workload identified in the ACM-02 data.

* In the interim NAMS Report 2961 was renamed 7961.

Table III-1

WEEKLY MAINTENANCE MANHOUR COMPARISON

	Average Weekly Maintenance Manhours(a)					Total
	Aircraft					
	A-6/KA-6	EA-6B	E-2C	F-14A	S-3A	
Original set of component manhours from rpt 2961	688	205	182	1218	764	3057
Components added and rpt 7961 manhours	915	292	213	1484	1065	3969
Update with special NAMS0 extract	972	338	329	2097	1452	5188
ACM-02 data	1486	889	489	2568	1281	8464

(a) Based on wartime flying rate.

POTENTIAL UNDERREPORTING OF DEMAND

The demand data in the CABAL data base are based on fleet 3M reporting. There are at least three reasons why 3M-reported demand may understate actual experience:

- o Removals/flying hour were developed using recorded demand for one individual item and worldwide flying hours for a particular aircraft. (This essentially parallels the procedure used by the Navy.) There may, however, be a number of stock numbers for components that fill a particular "hole" in an aircraft. Thus use of worldwide flying hours to compute a removal rate overstates utilization of any one configuration of the items (and understates the demand rate). There is no way to establish individual component flying hours, which would be required to develop a more meaningful failure rate. The

decision to update stock numbers of components considered in the study to the family head configuration was based in part on the assumption that demand recorded against this configuration will approximate most accurately the true demand for the item.

- o Demands for consumables are recorded in 3M based on 3M "60 series" card reporting. Since these cards have a very low keypunch priority, 3M-recorded demands tend to be understated. There is no alternative source of data that ties demands to the aircraft generating these demands.
- o The Visual Information Display System/Maintenance Action Form (VIDS/MAF), the form used to document maintenance actions in the 3M system, may not always be filled out. In addition to affecting reported demand, failure to document maintenance actions reduces the sample size used in computing mean repair times, BCM actions, and other items.

These data quality problems were ultimately either resolved or reduced in magnitude to the point where they had little potential for biasing the analysis. Hence their primary effect was to increase the cost of developing the CABAL data base.

Since the data used by CABAL also serve a number of other purposes, several of these problems identify deficiencies in current Navy data reporting and processing that warrant corrective action. In most cases, identification of the problem points the way toward solution. In a few cases--notably maintenance of test equipment availability data and the procedures used to accumulate manhours--more extensive work is needed to resolve the problem.

Appendix A

MASTER AVIONICS COMPONENT LIST

1. Type/Model/Series (TMS)
 - a. Sources: (1) Avionics Equipment Configuration List
(2) NAMS0 Report 2961
 - b. Use: Maintain aircraft identity in the files
2. Work Unit Code (WUC)
 - a. Source: ASO MK0001
 - b. Backup source: MCRL and NAMS0 Report 2961
 - c. Uses
 - (1) Aggregation of workloads by work unit code for manpower analysis
 - (2) Tie components to test equipment
 - (3) Associate components with subsystems
3. National Stock Number (NSN) - Head of Family
 - a. Subelements
 - (1) Cognizance Symbol (COG)
 - (2) Federal Stock Class (FSC)
 - (3) National Item Identification Number (NIIN)
 - (4) Special Material Identification Code (SMIC)
 - b. Sources
 - (1) Weapon Replaceable Assemblies (WRAs):
 - (a) Primary--

Avionics Equipment Configuration List (AECL)
for USS CONSTELLATION, updated through the
alternate NIIN tape

(b) Secondary--

NAMSO Report 2961

- (2) Shop Replaceable Assemblies (SRAs)/Lower levels of indenture; Top Down Breakdown of WRAs from the ASO Weapon System File, updated through the alternate NIIN tape

c. Uses

The NIIN is the primary key for relating the component files in the CABAL data base, which were cross-referenced to additional files for test equipment and manpower (through the NIIN-WUC linkage). It was also the element used to extract data from other sources.

4. Family/Group Code

- a. Source: Alternate NIIN tape
- b. Use: Dealing with alternate NIIN problems

5. Aircraft Subsystem Code

a. Sources

- (1) AECL for WRAs. This code was carried down to successive levels of indenture.
- (2) Manual research of the NACL R-5 report which associates subsystem code with equipment nomenclature

b. Uses

- (1) Subsystem-test equipment map, test equipment data base (to be documented later)
- (2) Develop lists of specific WRAs to be tied to test equipment through a manual data collection effort

6. IOL Code (the key to ASO stockage allowance tables)

- a. Source: AECL for WRAs. This code was carried down to successive levels of indenture.
- b. Use: Comparison of "emulated" (Rand-computed) AVCAL with IOL tables computed by ASO

7. Component Code

- a. Source: AECL for WRAs
 - b. Use: Component file used to access allowance information in the IOL for comparison with the "emulated" AVCAL.
8. Sequence Code
- a. Source: ASO Top Down Breakdown
 - b. Use: Identification of indenture relationships
- 8a. Record Code
- a. Source: ASO Top Down Breakdown
 - b. Use: Processing the Avionics Component Master List
9. Material Control Code
- a. Source: MCRL
Backup: NAMS0 Report 2961 and NMDL
 - b. Uses
 - (1) Identify items subject to special inventory control procedures (especially CLAMP)
 - (2) Identify reparable items with a consumable cognizance symbol (1RD)
10. Common Item Code (identifies items with multiple applications)
- a. Source: Special cross-reference runs with the CABAL data base
 - b. Use: Special consideration in both requirements and performance model runs
11. Quantity Per Application (QPA)
- a. Source: ASO Top Down Breakdown
 - b. Use: Adjusting demand data to recognize multiple applications of an item
12. NIIN Nomenclature
- a. Source: MCRL
Backup: NAMS0 Report 7961

13. Supply Maintenance and Recoverability (SM&R) Code
 - a. Source: MCRL
Backup: NAMS0 Report 2961
 - b. Use: Identify I-level reparable items
14. Price
 - a. Source: NMDL
 - b. Use: Computing stockage and pipeline costs
15. Work Center Code
 - a. Source: NAMS0 Report 2961.
Special cross-reference runs with CABAL data bases.
 - b. Uses: Aggregate maintenance data to work centers for use in manpower and test equipment analyses
16. Total Removals (afloat, ashore, and worldwide)
 - a. Source: ASO MK0001 tape, which is a processed extract from the NAMS0 data base
 - b. Use: This element is extremely important for performance calculations because it is fundamental in defining demand for
 - (1) Stock
 - (2) Maintenance resources (manpower and test equipment)
 - (3) Transportation
17. Percent I-Level Repair-Action-Taken Codes (ATC) A, B, C, D, J, K (afloat, ashore, and worldwide)
 - a. Source: ASO MK0001
 - b. Uses
 1. Workload estimation
 2. Sizing I-level pipelines
18. Average Turn Around Time (afloat, ashore, and worldwide)

a. Sources

- (1) ASO MK0001 (constrained values)
- (2) ASO MK0002 (actual values)

b. Uses

- (1) Stockage calculations
- (2) Performance calculations
- (3) Sizing I-level pipelines

- 19. Average In Process Days (see 18)
- 20. Average Awaiting Parts Days (see 18)
- 21. Average Scheduling Days (see 18)
- 22. Average Repair Days (see 18)
- 23. Percent BCM - ATC 1 thru 9 (afloat, ashore, and worldwide)
 - a. Source: ASO MK0001
 - b. Use: Sizing Depot Pipelines
 - c. Note: Elements 24-27 are subsets of 23.
Percents are based on total repairs.
- 24. Percent BCM-ATC 1 (depot repair only) (see 23)
- 25. Percent BCM-ATC 4 (no parts) (see 23)
- 26. Percent BCM-ATC 9 (see 23)
- 27. Percent No Defect - ATC A or J (see 23)
- 28. Removals/Flying Hour (afloat, ashore, and worldwide)
 - a. Source: B-16 divided by flying hours from NAMS0
Report 2958
 - b. Use: Translate scenario flying rates into
removals/day to size pipelines, establish stockage
requirements, compute performance
- 29. Removals/Sortie (afloat, ashore, and worldwide) (see 28)
- 30. Percent Repairs with Some AWP Time

- a. Source: NAMS0 Report 2961
- b. Use: Statistical analyses of delays due to AWP
- 31. Average Days AWP for Items with AWP Time (see 30)
- 32. Average Days TAT for ATC A (no defect)
 - (a) Source: NAMS0 Report 2961
 - (b) Use: Modeling repair process
- 33. Average TAT for ATC 4 (BCM due to lack of parts) (see 32)
- 34. Average Days AWP for ATC 4 (see 32)
- 35. Average Days TAT for ATC 2, 3, 5-9 (see 32)
- 36. Average I-Level Direct Maintenance Manhours (DMMH)-ATC A (no defect)
 - a. Source: NAMS0 Report 2961
 - b. Use: Aggregate manhours from scenario-driven removal data for manpower requirements estimation
- 37. Average I-Level DMMH-ATC B, C, K, Z (repair; see 36)
- 38. Average I-Level Elapsed Maintenance Time, ATC B, C, K, Z
 - a. See 36
 - b. Use: Estimation of test station time and maintenance team size (number of men required to accomplish a repair)
- 39. Gross Weight
 - a. Source: DoD Material Distribution Study (DODMDS)
 - b. Use: Provide movement requirements for transportation analysis
- 40. Gross Cube (see 39)
- 41. Navy Enlisted Classification (NEC) Code
 - a. Source: NAVMACLANT NEC to WUC cross reference (provided by NAMS0)
 - b. Use: Aggregate workloads to skills for manpower requirements calculations

42. Test Equipment (requirements)

- a. Source: Special manual data collection effort
(Element 5 links aircraft subsystem to test equipment;
this element associates specific components with the
test equipment)
- b. Use: Estimate workloads for test equipment used in:
 - (1) Test equipment analysis
 - (2) Estimating test equipment queuing for performance
modeling

43. Depot Repair Times

- a. Source: ASO selective item generator tape
 - (b) Use: Sizing depot pipeline

Appendix B

PRIMARY DATA SOURCES

A - Equipment Configuration

- (1) AECL for USS CONSTELLATION (1979 deployment)
- (2) ASO Top-Down Breakdown

B - Operations: NAMS0 Report 2958

C - Maintenance, Supply, and Transportation

(1) Key reports

- a. ASO MK0001 - 3M data extracted by NAMS0 for ASO use
Period covered: July 78 - June 79
- b. NAMS0 Report 2961 - Additional maintenance data
Period covered: July 78 - June 79
- c. NAMS0 Report 7961 - Additional maintenance data
for period July 79 - June 80
- d. ASO MK0002 - 3M data extracted by NAMS0 for ASO use
Period covered: July 79 - June 80
- e. Special NAMS0 manhour expenditure extract

(2) Other data

- a. Raw 3M for July 78 - June 79
- b. Data used to create CONSTELLATION AVCAL
 - (1) IOL extract
 - (2) SAVAST tape
- c. Master cross-reference list (MCRL)
- d. Extracts from the ASO MDF
- e. DoD Material Distribution Study (DODMDS)
- f. Navy Management Data List (NMDL)

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g. ASO alternate NIIN

h. NAVMACLANT NEC to WUC cross reference

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